6. (Amended) A laminate sheet of a copper-alloy foil and liquid crystal polymer according to claim 4 or 5, wherein said copper-alloy foil which has been heated to 350°C or higher for 1 hour, so the tensile strength is intermediate between that prior to heating and that after fully annealed.

## REMARKS

**Specification (Paragraph 1 of Office Action)**

The Examiner objects to the specification at page 4, line 9 for reciting "ICAS". The Examiner requests that Applicants amend this portion of the specification to recite "IACS (International Accepted Conductivity Standard)". The objection to the disclosure as set forth by the Examiner is respectfully traversed. Reconsideration and withdrawal thereof are requested.

The specification at page 4, line 9 has been amended to recite "IACS (International Annealed Copper Standard)" rather than the IACS definition suggested by the Examiner. Attached hereto is 1996 Annual Books of ASTM Standards B5-95. The Examiner should note Section 6.1 Electrical Resistivity.

Accordingly, in view of the remarks hereinabove and in view of the amendments to the specification, the objection to the specification should be withdrawn by the Examiner.

**Claim Objections (Paragraph 2 of Office Action)**

The Examiner objects to claim 6 for not clearly reciting the manner in which the copper-alloy foil is heated. The objection to the disclosure as set forth by the Examiner is respectfully traversed. Reconsideration and withdrawal thereof are requested.

Applicants have amended claim 6 to address the matters raised by the Examiner.

Accordingly, in view of the amendments to claim 6, the objection to the specification should be withdrawn by the Examiner.

**Rejection of Claims 1-8 Under 35 U.S.C. § 112, Second Paragraph (Paragraphs 3-4 of Office Action)**

Claims 1-8 are rejected by the Examiner under 35 U.S.C. § 112, second paragraph, as being indefinite. This rejection is respectfully traversed. Reconsideration and withdrawal thereof are requested.

The Examiner objects to claims 1, 2 and 4-5 for reciting that the copper-alloy foil has a "50% IACS or more of electrical conductivity". The Examiner finds that this phrase renders the claims indefinite, since there is no teaching within the specification as to the temperature and frequency at which the conductivity is measured. The Examiner also objects to claims 1, 2 and 4-5 for containing a parenthetical expression.

The claims have been amended to remove the parenthetical expression. With respect to the phrase "50% IACS or more of

electrical conductivity," the measurement is carrier out with respect to the temperature only. However, since the term IACS is well known in the art, the indicated limitation is clearly not indefinite. See the attached 1996 Annual Books of ASTM Standards B5-95, especially note Section 6.1 Electrical Resistivity discussed above.

Applicants' amendments to the claims are clearly non-narrowing in nature.

Accordingly, in view of the remarks hereinabove and in view of the amendments to the claims, the rejection to claims 1-8 under 35 USC 112, second paragraph, should be withdrawn by the Examiner.

**Rejection of Claims 1-8 Under 35 U.S.C. § 102 and 103 (Paragraphs 6-8 of Office Action)**

Claims 1-3 are rejected by the Examiner under 35 U.S.C. § 102(a) or (b) as being anticipated by JP 09157775A (JP'775). Claims 4-8 are rejected by the Examiner under 35 U.S.C. 103(a) as being unpatentable over the admitted prior art in view of JP '775. These rejections are respectfully traversed. Reconsideration and withdrawal thereof are requested.

The Present Invention

The present invention as recited in claim 1, as amended, relates to a copper-alloy foil used for a laminate sheet, which contains, by weight percentage, one or more of from 0.01 to 2.0% of Cr and from 0.01 to 1.0% of Zr, the balance being copper and unavoidable impurities, and which comprises on the outermost surface, an oxide layer and a rust-proof film which taken together are greater than 0 nm up to and including 10 nm in thickness, and 50%IACS or more of electrical conductivity, and 5.0N/cm or more of 180° peeling strength when thermally fusion-bonded with a liquid crystal polymer.

Accordingly, claim 1 has been amended to clarify that the rust-proof film is present. The thickness is thus that of the total oxide and rust proofing film taken together.

The JP 09157775A (JP'775) Reference

Present claims 1, 2, 4 and 5 recite that copper-alloy foil has: (i) a 50% IACS or larger of electrical conductivity; and (ii) 5.0N/cm or more of 180° peeling strength when thermally fusion-bonded with a liquid crystal polymer. The Examiner has taken the position that the copper-alloy foil of JP'775 inherently has these properties.

Admitted Prior Art

The Examiner is using the disclosure of the present application in finding that the present invention is obvious. The Examiner views the disclosure of page 3, lines 21+ of the present specification as admitted prior art. At this section, the present inventors teach that the prior art has attempted to thermally fusion bond the liquid crystal resin substrate and copper foil without a binder. The Examiner has (improperly) taken the position that it would be obvious to replace this copper foil (page 3, line 22) with the copper-alloy of JP'775.

Distinctions Between the Present Invention and the Prior Art

Claim 1, as amended, requires the presence of the rust-proof film. The thickness of 10nm or less is thus that of the total oxide and rust proofing film. These features of the present invention are nowhere disclosed or suggested by the prior art references either taken alone or in combination.

In order to support Applicants' position, the Examiner's attention is directed to the description at page 6, lines 22-30 of the present specification, which is reproduced below for the Examiner's convenience:

> In addition, benzotriazole or the like is usually applied to the foil to prevent further oxidation of the foil surface from advancing. A rust-proof film is thus formed on the foil surface. When the rust-proof film is too thick, it decomposes during the heating of the resin and laminating with the foil. The rust-proof film is, therefore, liable to peel from the foil. As a result, the adherence with the resin is, therefore, lowered. Based on the researches by the present

> inventors, the thickness of the oxide layer should be limited to 10 nm or less measured from the surface of the foil material, so as to prevent the decrease of adherence. In a case that a rust-proof layer is present, its thickness should also be limited to 10 nm or less measured from the surface of the foil, as well.

In addition, the Examiner is improperly using Applicants' specification as a guide in finding the inventive laminate sheet obvious. Thus, the combination of references as suggested by the Examiner is improper and does not correct the deficiencies of JP '775 for the reasons discussed above.

In view of the amendments to the claims and in view of the remarks hereinabove, the rejection of the claims under 35 U.S.C. 102(a)/102(b)/103(a) over JP '775 taken alone or in combination with the admitted prior art should be withdrawn by the Examiner.

Pursuant to 37 C.F.R. §§ 1.17 and 1.136(a), Applicant(s) respectfully petition(s) for a one (1) month extension of time for filing a reply in connection with the present application, and the required fee of $110.00 is attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

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1823-0113P

**MARKED-UP VERSION SHOWING THE CHANGES MADE**

IN THE SPECIFICATION

The paragraph beginning on page 4, lines 4-15, has been amended as follows:

The peeling strength required for a printed circuit board is dependent upon the conditions of process and the environment in which the electronic machines are used. However, generally speaking, 5.0N/cm or more of 180° peeling strength is considered to enable practical application of the printed circuit board. Therefore, the target value of 180° peeling strength according to the present invention is 5.0N/cm or more. In addition, the target value of electrical conductivity is 50% [ICAS] IACS (International Annealed Copper Standard) or more. The target value of heat resistance is determined by consideration for taking soldering with electronic parts or thermal fusion-bonding with the liquid crystal polymer. The thermal resistance is defined by the value of the heating temperature, at which the tensile strength after heating for 1 hour is reduced to an intermediate level between that of prior to heating and that after fully annealed. The target value of heating temperature is 350°C or more.

The paragraph beginning on page 9, lines 4-8, has been amended as follows:

(4) Heat Resistance. Heating is carried out at a predetermined temperature for 1 hour. Tensile strength is then measured at room temperature. The heating temperature, at which the measured tensile strength is intermediate between that prior to heating and the heated and fully softened tensile strength is identified [dientified] as the softening temperature.

IN THE CLAIMS

The claims are amended as follows:

1. (Amended) A copper-alloy foil used for a laminate sheet, which contains, by weight percentage, one or more of from 0.01 to 2.0% of Cr and from 0.01 to 1.0% of Zr, the balance being copper and unavoidable impurities, and which comprises on the outermost surface, [a 10 nm or less (excluding 0 nm) thick] an oxide layer and [occasionally] a rust-proof film which taken together are greater than 0 nm up to and including 10 nm in thickness, and 50%IACS or more of electrical conductivity, and 5.0N/cm or more of 180° peeling strength when thermally fusion-bonded with a liquid crystal polymer.

2. (Amended) A copper-alloy foil used for a laminate sheet, which contains, by weight percentage, one or more of from 0.01 to 2.0% of Cr and from 0.01 to 1.0% of Zr, and which further contains from 0.005 to 2.5% in total of at least one element selected from the group consisting of Ag, Al, Be, Co, Fe, Mg, Ni, P, Pb, Si, Sn, Ti and Zn, the balance being copper and unavoidable impurities, and comprises on the outermost surface, [a 10 nm or less (excluding 0 nm) thick] an oxide layer and [occasionally] a rust-proof film which taken together are greater than 0nm up to and including 10nm in thickness, and 50%IACS or more of electrical conductivity, and 5.0N/cm or more of 180° peeling strength when thermally fusion bonded with a liquid crystal polymer.

3. (Amended) A copper-alloy foil according to claim 1 or 2, [having] which has been heated to 350°C or higher [of heating temperature, at which] for 1 hour, so the tensile strength [after heating for 1 hour] is intermediate between that prior to heating and that after fully annealed.

4. (Amended) A laminate sheet of a copper-alloy foil and liquid crystal polymer thermally fusion-bonded without a binder, wherein said copper-alloy foil contains, by weight percentage, one or more of from 0.01 to 2.0% of Cr and from 0.01 to 1.0% of Zr, the balance being copper and unavoidable impurities, and comprises on the outermost surface, [a 10 nm or less (excluding 0 nm) thick] an oxide layer and [occasionally] a rust-proof film which taken together are greater than 0nm up to and including 10nm in thickness, and 50%IACS or more of electrical conductivity, and 5.0N/cm or more of 180° peeling strength when thermally fusion bonded with a liquid crystal polymer.

5. (Amended) A laminate sheet of a copper-alloy foil and liquid crystal polymer thermally fusion-bonded without a binder, wherein said copper-alloy foil contains, by weight percentage, one or more of from 0.01 to 2.0% of Cr and from 0.01 to 1.0% of Zr, and further contains from 0.005 to 2.5% in total of at least one element selected from the group consisting of Ag, Al, Be, Co, Fe, Mg, Ni, P, Pb, Si, Sn, Ti and Zn, the balance being copper and unavoidable impurities, and comprises on the outermost surface, [a 10 nm or less (excluding 0 nm) thick] an oxide layer and [occasionally] a rust-proof film which taken together are greater than 0nm up to and including 10nm in thickness, and 50%IACS or more of electrical conductivity, and 5.0N/cm or more

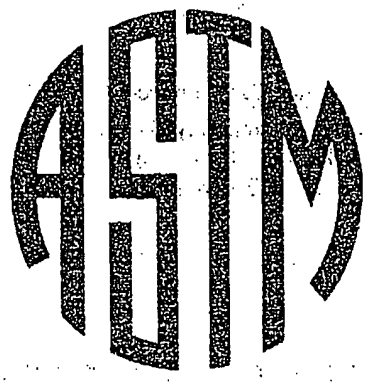
of 180° peeling strength when thermally fusion bonded with a liquid crystal polymer.

6. (Amended) A laminate sheet of a copper-alloy foil and liquid crystal polymer according to claim 4 or 5, wherein said copper-alloy foil which has been heated to 350°C or higher [of heating temperature, at which] for 1 hour, so the tensile strength [after heating for 1 hour] is intermediate between that prior to heating and [the heated and the] that after fully annealed.

# 1996 ANNUAL BOOK OF ASTM STANDARDS

SECTION 2

## Nonferrous Metal Products



VOLUME 02.01

## Copper and Copper Alloys

***Includes standards of the following committee:***

B-5 on Copper and Copper Alloys

Publication Code Number (PCN): 01-020196-03

ASTM 100 Barr Harbor Driv , West Conshohocken, PA 19428 ■ (610) 832-9500 ■ FAX: 610-832-9555

Designation: B 5 – 95

# Standard Specification for High Conductivity Tough-Pitch Copper Refinery Shapes[1]

This standard is issued under the fixed designation B 5; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This specification has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.*

## 1. Scope*

1.1 This specification establishes the requirements for high conductivity tough-pitch copper wire bars, cakes, slabs, billets, ingots, and ingot bars.

1.2 Copper under this specification corresponds to the designations "ETP" (UNS C11000) and "FRHC" (UNS C11020) as shown in Classification B 224. These coppers may also be used to produce coppers corresponding to the following:

| Copper UNS No. | Classification B 224 Designation |
|---|---|
| C11300, C11400, C11500 & C11600 | STP |
| C12000 | DLP |
| C12200 | DHP |
| C12300 | DHPS |
| C14500 | DPTE |

1.3 Although this specification includes certain UNS designations as described in Practice E 527, these designations are for cross reference only and are not specification requirements. Therefore in case of conflict, this ASTM specification shall govern.

1.4 In this specification inch-pound units are the standard except for electrical resistivity which is expressed in SI units. The values given in parentheses are for information only.

## 2. Referenced Documents

2.1 *ASTM Standards:*

B 193 Test Method for Resistivity of Electrical Conductor Materials[2]

B 224 Classification of Coppers[3]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

E 53 Methods for Chemical Analysis of Copper[5]

E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition[5]

E 478 Test Methods for Chemical Analysis of Copper Alloys[5]

E 527 Practice for Numbering Metals and Alloys (UNS)[6]

## 3. Terminology

3.1 For definitions specific to this specification, refer to Classification B 224.

## 4. Ordering Information

4.1 Orders for product under this specification should include the following information:

4.1.1 ASTM Specification Designation and year of issue,

4.1.2 Copper UNS No. Designation,

4.1.3 Quantity, shape and dimension of each piece, and weight,

4.1.4 Should cakes, slabs, or billets be ordered for electrical use, it must be stated in the contract or purchase order.

4.1.5 Silver content in silver bearing shapes when required, in troy oz per short ton,

4.1.6 When material is purchased for the agencies of the U.S. government.

## 5. Chemical Composition

5.1 The copper in all shapes shall meet the minimum requirement for copper, including silver, of 99.90 %.

5.1.1 This composition limit does not preclude the presence of other elements. Limits for unnamed elements may be established, and analysis required, by agreement between the supplier and the purchaser.

5.2 For the STP (silver-bearing) coppers, the addition of silver up to an average of 30 troy oz per short ton (0.10 %) will be considered within the specification, with no individual silver analysis to exceed 35 troy oz per short ton (0.12 %).

## 6. Physical Properties

6.1 *Electrical Resistivity:*

6.1.1 The maximum mass resistivity for wire bars, cakes, slabs, and billets for electrical use shall be 0.15328 $\Omega \cdot g/m^2$ (conductivity 100.0 % minimum, International Annealed Copper Standard, (IACS)), at 68°F (20°C), annealed.

6.1.2 The maximum mass resistivity for other uses shall be 0.15694 $\Omega \cdot g/m^2$ (conductivity 97.66 % minimum IACS), at 68°F (20°C), annealed.

6.1.3 The maximum mass resistivity for ingots and ingot bars shall be 0.15694 $\Omega \cdot g/m^2$ (conductivity 97.66 % minimum IACS), at 68°F (20°C), annealed.

## 7. Purchases for U.S. Government

7.1 When specified in the contract or purchase order, product purchased for agencies of the U.S. Government shall

[1] This specification is under the jurisdiction of ASTM Committee B-5 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.07 on Refined Copper.

Current edition approved Sept. 10, 1995. Published November 1995. Originally published as B 5 – 11. Last previous edition B 5 – 89.

[2] *Annual Book of ASTM Standards*, Vol 02.03.

[3] *Annual Book of ASTM Standards*, Vol 02.01.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 03.05.

[6] *Annual Book of ASTM Standards*, Vol 01.01.

* A Summary of Changes section appears at the end of this standard.